TECHNICAL MEMORANDUM

Screening Level Ecological Risk Assessment Approach

Area 4 Former Universal Oil Products Site

East Rutherford, New Jersey

Honeywell International Inc.

Morristown, New Jersey

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1.0 Introduction

This technical memorandum outlines the process for conducting the Screening-Level Ecological Risk Assessment (SLERA) for Operable Unit 3 (OU3) at Area 4 of the former Universal Oil Products (UOP) site in East Rutherford, New Jersey. The SLERA will be conducted to evaluate whether contaminants present in Area 4 of the UOP site represent a potential risk to exposed aquatic and semi-aquatic flora and fauna. Based on the outcome of the SLERA, recommendations will be made about the need for additional investigation, including the initiation of a Baseline Ecological Risk Assessment (BERA).

The methods and approaches that are outlined in this Ecological Risk Assessment (ERA) protocol were developed from applicable U.S. Environmental Protection Agency (USEPA) ERA guidance (e.g., USEPA 1997, 1998). As described in USEPA ERA guidance (USEPA 1997, 1998), an ERA consists of three main components: (1) problem formulation, (2) analysis, and (3) risk characterization. Problem formulation involves: (1) compiling and reviewing existing information on the habitats and biota potentially present on the site and in the site vicinity; (2) developing exposure scenarios; (3) developing a conceptual model that identifies and evaluates potential source areas, transport pathways, fate and transport mechanisms, exposure media, exposure routes, and receptors; and (4) developing assessment and measurement endpoints for all complete exposure pathways. The preliminary problem formulation for the ERA is provided in Section 3 of this protocol.

The two remaining components of the ERA, analysis and risk characterization are described in Section 3 of this protocol. The analysis portion of the ERA is divided into two main parts, effects assessment and exposure assessment. The principal activity associated with the effects assessment is the development of chemical exposure levels that represent conservative thresholds for adverse ecological effects. The exposure assessment involves estimating exposures to potential ecological receptors for the exposure scenarios identified in the preliminary problem formulation. The principal activity associated with the exposure assessment is the estimation of chemical concentrations in applicable media to which the receptors might be exposed. The risk characterization portion of the ERA uses the information generated during the two previous parts of the ERA (problem formulation and analysis) to calculate potential risks to ecological receptors for the exposure scenarios evaluated. Also included is an evaluation of the uncertainties associated with the models, assumptions, and methods used in the ERA, and their potential effects on the conclusions of the assessment.

2.0 Background

2.1 Description of the Facility

The UOP site is located near the intersection of Route 17 and Paterson Plank Road in the Borough of East Rutherford, Bergen County, New Jersey (Figure 2-1). The property is surrounded by tidal marshes, highways, and commercial and light industrial property. Immediately to the north is the Matheson Gas Products site, an automotive storage lot, the former Meadowlands Plating & Finishing site and a Fairfield Inn Motel. Berry's Creek and tidal marshes are located to the east, while Ackerman's Creek and commercial properties are located to the south. West of Route 17 is the former Becton Dickenson site, a catering, restaurant, and other commercial properties. The closest residential area is approximately one-quarter mile to the west of Route 17.

The UOP property is approximately seventy-three acres, of which approximately fifty percent is developed land and built up with miscellaneous earthen fill, municipal type waste and rubble (elevations range from 4 to 9 feet above mean sea level). The developed area is commonly referred to as the Uplands. The remaining half of the property is covered by a tidal salt marsh and man-made Ackerman's Creek. An active Conrail/NJ Transit right-of-way runs North-South and separates the Uplands into two unequal areas. The area east of the railroad tracks consists of 45 acres, and the area west of the tracks consists of 30 acres.

From 1932 through 1979, an aroma and fragrance laboratory business, in addition to other industrial chemical companies, operated within the Uplands property. The Uplands area was initially developed in 1932 by Trubeck Laboratories (Trubeck) which built and operated the aroma chemicals laboratory. Trubeck began operating a solvent recovery facility in 1955. In 1956, Trubeck constructed a wastewater treatment plant, and in 1959 began utilizing two wastewater holding lagoons. UOP, a division of the Signal Companies, acquired the property and facilities in 1960. The wastewater treatment plant and wastewater lagoons ceased being used in 1971. All remaining operations at the facility were terminated in 1979. In 1980, all structures, except concrete slabs and a pedestrian bridge over the NJ Transit tracks, were demolished. The contents of the two wastewater lagoons were removed under an Interim Remedial Measure, and transported offsite for disposal in 1990.

In 1986, Allied Corporation merged with the Signal Companies forming AlliedSignal. AlliedSignal acquired the UOP property as part of the merger and thereby acquired the inactive UOP property. In 1999, Honeywell International, Inc (Honeywell), merged with AlliedSignal, and in doing so, became responsible for the environmental liability at the UOP site.

The New Jersey Department of Environmental Protection (NJDEP), Bureau of Federal Case Management has been the lead oversight agency at the UOP site since 1982. In addition, both the United States Environmental Protection Agency (USEPA) Region II and the New Jersey Meadowlands Commission have provided an integral role in the regulatory oversight of remedial activities.

The UOP site was added to the National Priorities List (NPL) on September 8, 1983. An Administrative Consent Order (ACO) was issued by NJDEP (NJDEP-1983) to perform a Remedial Investigation (RI), the purpose of which was to chemically characterize and delineate areas of soil and groundwater impacts that may require remedial action. UOP entered into a second ACO in May 1986 in which UOP agreed to continue site investigations, and conduct a feasibility study (FS) of remedial action alternatives for the various areas at the site. In 1986, following the merger, AlliedSignal (now Honeywell) became responsible for completing the characterization activities initiated in 1983. In accordance with the ACO, remedial investigations and studies continued at the site.

The UOP site was divided into five functional areas based on historic operations as indicated on Figure 2-2:

Operable Unit 1 (OU1)

Area 1: North central part of property;

Area 1A: Central part of property;

Area 2: Western part of the property;

Area 5: OU1: Area East of Areas 1 and 1A.

Operable Unit 2 (OU2)

Area 3: Wastewater lagoons;

Operable Unit 3 (OU3)

Area 4: Surface water channels; and

The lagoon berm, on-site tidal stream channels, and upland/tidal areas at the site have been consolidated into Area 4 (also known as the Streamlands). The investigation at Areas 1, 1A, 2, 3, and 5 have been completed. Honeywell completed the remediation of Area 1, 1A, 2, and 5 including the storm sewer system in 1997. As part of that remediation effort, 200 cubic yards (CY) of sediment were removed from the storm sewer system. In addition, approximately 1,250 CY of soil was removed as part of the sewer replacement activities. These activities are described in more detail in *Remedial Action Report Area 2- Block 104, Lot 2, UOP Uplands Site Remediation, East Rutherford, New Jersey*, dated November 1997, prepared by ENSR.

The focus of this technical memorandum is the ecological assessment of Area 4, Streamlands (OU3). Area 4 is the only area of the site requiring further investigation. This area consists of the former lagoon berms, stream channels, and upland tidal areas.

2.2 Previous Investigations

In April 1990, ENSR prepared a remedial investigation report (RIR) on behalf of Honeywell that addressed the tidal stream channels within the UOP property and the channels adjacent to the property. The RIR was based on data collected during several phases of investigation beginning in 1983 and ending in January 1990. During the 1983 to 1988 investigations, sediment samples were collected. From November 1989 through January 1990, sediment samples were collected along with soils beneath the sediments and soils in marshlands adjacent to the stream channels. These samples were analyzed for polychlorinated biphenyls (PCBs), priority pollutant metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and total organic carbon (TOC).

Results of this investigation identified chromium, mercury, PCBs, PAHs, and certain volatile organic compounds as the most pervasive contaminants in the channel sediments. PCBs were detected in both on and off-site (Walden Marsh) stream channels, and indicated a potential source in the vicinity of the former wastewater lagoon. Chromium and mercury appeared to be ubiquitous throughout much of the stream channels; however, both metals were detected at lower concentrations in areas that did not contain significant organic carbon, which was attributed to the retention of the elements in organic media, specifically the sedimentary organic layer. It was previously hypothesized that mercury had migrated downstream within Berry's Creek and into side channels such as Ackerman's Creek. Subsequently, the flushing action within Berry's Creek was thought to have transported mercury away from the center of the creek, as evidenced by the limited sediments, while the metals remained in the stagnant side channels. Chlorobenzene and PAHs were detected primarily in the North Ditch (Area 1), adjacent to the wastewater lagoons, and in channels outside the UOP property (Walden Marsh). The source of PAHs is uncertain, but they may be related to historic site activities or natural sources (e.g., phragmites brush fires) and non-site related activities such as Route 17 and Route 120 storm water or other offsite sources.

Based on the RIR, further sediment characterization was requested by the NJDEP and EPA Region II. Site-specific information on various physical parameters in Ackerman's Creek, Berry's Creek, and Area 4 wetlands was needed to develop an understanding of the pathways by which surface waters flow into, through, and from the site. Further chemical characterization of sediments, soils, and biota was also needed, particularly in depositional areas. This characterization would enable further understanding of the influence of the UOP site on Berry's Creek, and the identification of any active and remnant sources of contamination to Ackerman's Creek. The results of these additional investigations will be incorporated into the ERA for the Area 4 Streamlands.

3.0 Preliminary Problem Formulation

Problem formulation establishes the goals, scope, and focus of the ERA. As part of problem formulation, the environmental setting of a site is characterized in terms of the habitats and biota known or likely to be present, and the types of chemicals that are present in ecologically relevant media. A conceptual model is developed for the site that describes potential sources, potential transport pathways, potential exposure pathways and routes, and potential receptors. Assessment and measurement endpoints are then selected to evaluate those receptors for which complete and potentially significant exposure pathways are likely to exist for the exposure scenarios evaluated. The fate, transport, and toxicological properties of the chemicals present at a site are also considered during this process.

3.1 Environmental Setting

3.1.1 Physiographic Features

The UOP Site is located in the Meadowlands of northern New Jersey, only a few miles west of New York City. The Meadowlands is the largest remaining tidal marsh complex (3,400 hectares) in the New York-New Jersey Harbor Estuary, and is a mosaic of salt water and freshwater tidal wetlands, freshwater non-tidal wetlands, uplands, and developed areas.

The Area 4 Streamlands consists of the former lagoon berms, stream channels, and upland tidal areas (Figure 3-1). The major surface water features within the vicinity are Berry's Creek and the Hackensack River. Ackerman's Creek and unnamed stream channels are located on the property and are tributaries to Berry's Creek. Berry's Creek provides hydrology to Walden Marsh and its associated unnamed tributaries. The Berry's Creek sub-basin drains an area of approximately 7,686 acres (Edwards and Kelcey, 2005). At one time Berry's Creek emanated from a large freshwater swamp in the northern end of the basin that drained into the tidal portion of the creek and flowed south through Eight Day Swamp and Walden Marsh before emptying into the Hackensack River. Today, Teterboro Airport occupies the former freshwater swamp in the northern end of the basin. Eight Day Swamp and Walden Marsh have also been significantly reduced in size as a result of encroaching development. The Hackensack River originates as a freshwater stream in central Rockland County, New York flowing south for approximately 34 miles before emptying into Newark Bay (USACE, 2002, as cited in Edwards and Kelcey 2005). The Hackensack River is a brackish estuarine river system where it receives Berry's Creek, in which saline waters from the ocean mix with freshwater draining from the landscape.

According to USGS topographic maps, the Area 4 Streamlands are considered marsh or swamp up to Berry's Creek, and contain winding or straight channels (Ackermans' Creek) leading to Berry's Creek (ENSR, 1994). Soils in the area are considered Urban Land (Ur) (USDA/SCS 1989, as cited in ENSR 1994). Urban land is anthropological altered soil and typically consists of paved areas, fill, parking lots, and buildings. The National Wetlands Inventory Map identifies Area 4 as Estuarine Intertidal Emergent (E2EM) and Estuarine Open Water (E1OW). The NJDEPE map characterizes these same areas as Estuarine Intertidal Emergent Persistent Irregular, Palustine Open Water Permanent and Riverine Lower Perrenial Open Water Excavated.

Within the on-site stream channels and Ackerman's Creek, the sediment strata in the stream channels was found to consist of a 3.5 to 4 foot layer of alluvial sediments overlying clay or gravelly sand. The sediment layer within the deepest areas of Berry's Creek was observed to be eroded away to the underlying clay layer. The sediments, where present, were observed to be highly organic in content. The underlying soils were observed to be lower in organic carbon content than the sediments.

3.1.2 Habitat

The Area 4 Streamlands habitat consists of tidal fringe wetlands and creeks dominated by the common reed (*Phragmites australis*). Dense monocultures of *Phragmites* are thought to significantly decrease habitat heterogeneity (Roman et al. 1984, Marks et al. 1994) and increase the elevation of the marsh surface due to its high biomass production, ability to trap sediments, and slow decomposition rate (Windham 2001). Although the brackish waters in the Meadowlands may also be unnaturally stressed due to low dissolved oxygen, the habitat still provides for a variety of aquatic species including fish, crustaceans, waterfowl and benthic invertebrates (USEPA and USACE, 1995, as cited in Edwards and Kelcey, 2005).

3.1.3 Biota

Vegetation

The vegetation in the Area 4 Streamlands is largely monotypic stands of common reed (*Phragmites australis*) with isolated shrubs and trees such as Tree-of-Heaven (*Ailanthus altissima*) and Princess tree (*Paulownia tomentosa*). These species are categorized as invasive plant species according to the Natural Resources Conservation Service's (NRCS) Plants Database (Edwards and Kelcey 2005).

A wetland delineation performed by ENSR (1994) and a site visit performed by CH2M HILL in May 2005, identified several other tree species associated with the on-site wetlands in upland and transitional zones, including red maple (*Acer rubrum*), gray birch (*Betula populifolia*), eastern cottonwood (*Populus deltoides*), trembling aspen (*Populus tremuloides*), black locust (*Robinia pseudoacacia*), red oak (*Quercus rubra*), pin oak (*Quercus palustris*), and sweet gum (*Liquidambar styraciflua*). Other plant species identified on-site include common ragweed (*Ambrosia artemisifolia*), Canadian goldenrod (*Solidago canadensis*), small white aster (*Aster vimineus*), as well as various grass species.

Several plant species not identified on-site but observed in the vicinity as part of the field reconnaissance activities for the Meadowlands Railroad and Roadway Improvement Project are listed in Table 3-1 (Edwards and Kelcey, 2005). The bulk of these species are expected in Walden Marsh, which was considered to contain the majority of natural vegetation in the surveyed area.

Aquatic Invertebrates

The benthic invertebrate communities in the lower Hackensack River and its tributaries are dominated by more "pollution tolerant" species such as polychaete worms (Edwards and Kelcey, 2005). The benthic invertebrate community was assessed by the New Jersey Meadowlands Commission (NJMC) in it aquatic resource study prepared in 1987 and 1988. In that study, a total of 53 different invertebrate species were collected from the sediments in the Hackensack River and tributaries. Of the individuals collected, 36 percent were polychaetes, 15 percent were mollusks and 11 percent were amphipods (HMDC, 1989; as cited in Edwards and Kelcey, 2005). Polychaetes tend to be labeled as "habitat generalists" due to their ability to adapt to environmentally stressful conditions (USACE, 2002; as cited in Edwards and Kelcey, 2005).

Several species of invertebrates have been observed or are expected to occur on-site, including several different species of copepods, rotifers, nematodes, coleopterans, chironomidae (larvae of the aquatic midge family), barnacles (*Balanus eburnus*), gastropods (*Hydrobia minuta*), grass shrimp (*Palaemontes pugio*), mussel (*Mytilopsis leucophaeta* Congeria sp.), and blue crab (*Callinectes sapidus*) (ENSR, 1990).

Fish

The Hackensack River and its associated tributaries and marshes are known to support at least 34 different species of fish (HMDC, 1989; as cited in Edwards and Kelcey, 2005). These fish species include freshwater, estuarine, marine, and anadromous fishes. The dominant species of fish found in the lower Hackensack River system are the mummichog (*Fundulusm heteroclitus*), which represented approximately 90 percent of the individuals caught in an aquatic resource study completed in 1987 and 1988 (USEPA and USACE, 1995; as cited in Edwards and Kelcey, 2005). The mummichog has most likely become the dominant fish species due to its capabilities of adapting to and surviving the stress created by periods of low dissolved oxygen.

Berry's Creek has a high density of fish compared with other waterways within the HMD (NJMC Staff, personal communication; as cited in Edwards and Kelcey, 2005). According to unpublished results of recent fish survey by the New Jersey Meadowlands Commission, 14 different species of fish were caught in Berry's Creek. The most common species was white perch (*Morone Americana*), followed by blueback herring (*Alosa aestivalis*) and alewife (*Alosa pseudoharengus*). The NJDEP Division of Fish and Wildlife imposes timing restriction on construction activities within waterways supporting alewife and blueback herring between the dates of April 1st and June 30th.

Mammals

Mammal occurrence on the site is limited, most likely as a result of the roadways and other developed lands that surround the site. In a wildlife habitat survey performed in 2003 (NJSEA 2004; as cited in Edwards and Kelcey, 2005) and the May 2005 site visit, a limited number of mammal species were identified, including the grey squirrel (*Sciurus carolinensis*), groundhog (*Marmota monax*), red fox (*Vilpes vulpes*) and eastern cottontail (*Sylvilagus floridanus*). Dead carcasses of Norway rat (*Rattus norvegicus*) and muskrat (*Ondatra zibethica*) were also observed during the wetland delineation performed in June 2003 (NJSEA, 2004; as cited in Edwards and Kelcey, 2005). These species are all considered common suburban mammals. The common muskrat may be considered a keystone species in wetland areas, as its feeding and building activities have major effects on vegetation, soils, microtopography, and animal habitats (Kiviat and MacDonald, 2002). Muskrat numbers have also declined in Hudson River marshes in recent decades (Kiviat and MacDonald, 2002).

Birds

A total of 32 birds were observed on and around the Continental Airlines Arena Site at the Meadowlands Sports Complex during the field investigations performed in 2003 by Langan Engineering & Environmental Services (NJSEA, 2004; as cited in Edwards and Kelcey, 2005). As the Meadowlands Sports Complex is approximately one-eighth of a mile from the Streamlands, species observed in this survey are also considered representative of the Site. Herring gull (*Larus argentatus*) and mouring dove (*Zenaida macroura*) were the species most commonly observed. Barn swallow (*Hirundo rustica*), song sparrow (*Melospiza melodia*), European starling (*Sturnus vulgaris*), gray catbird (*Dumetella carolinensis*) and redwing blackbird (*Agelaius phoenicueus*) were also observed at several stations. Northern harrier (*Circus cyaneus*, State endangered/uncommon) was the only state threatened or endangered avian species observed within the area during previous studies. Yellow-crowned night heron (*Nyctanassa violaceus,* State threatened) foraging habitat also exists within one-quarter mile of the Site.

Although no field observations were conducted during the winter months, species such as the great black-backed gull (*Larus marinus*), ring-billed gull (*Larus delawarebsus*), white crowned sparrow (*Zonotrichia leucophrys*), dark-eyed junco (*Junco hyemalis*), and purple finch (*Carpodacus purpureus*) are known to inhabit the area.

Additional species observed during a May 2005 site visit include the American robin (*Turdus migratorius*), common yellowthroat (*Geothlypis trichas*), yellow warbler (*Dendroica petechia*), willow flycatcher (*Empidonax traillii*), cowbird (*Molothrus ater*), killdeer (*Charadrius vociferous*), tree swallow (*Tachycineta bicolor*), hairy woodpecker (*Picoides villosus*), Baltimore oriole (*Icterus galbula*), boat-tailed grackle (*Quiscalus major*),American Goldfinch (Carduelis tristis) mallard (*A. platyrhynchos*), spotted sandpiper (*Actitis macularius*), semipalmated sandpiper (*Calidris pusilla*), and Canada goose (*Branta Canadensis*).

Reptiles and Amphibians

The waters of the Meadowlands estuary complex exhibit oligohaline to mesohaline conditions with salinity levels ranging between one and 10 parts per thousand (ppt) (NJSEA, 2004; as cited in Edwards and Kelcey, 2005). Salinity levels greater than five ppt are difficult for most amphibians native to the area to tolerate. As result, few amphibians inhabit the Meadowlands. The green frog (*Rana clamitans*) and pickerel frog (*R. palustris*) are among these species (Kiviat and Macdonald, 2002; as cited in Edwards and Kelcey, 2005). Reptiles are more tolerant of elevated salinity levels. Garter snakes (*Thamnophis sirtalis*) and snapping turtles (*Chelydra serpetina*) have also been observed by personnel on the UOP Site. Certain reptiles such as the painted turtle (*Chrysemys picta picta*), black rat snake (*Elaphe obsolete obsolete*), and Northern brown snake (*Storeria dekayi dekayi*) may also occur in the undeveloped wetland and upland portions of the area (NJSEA, 2004; as cited in Edwards and Kelcey, 2005).

Threatened and Endangered Species

As part of Meadowlands Railroad and Roadway Improvement Project, a Preliminary Environmental Impact Statement (PEIS) was prepared by Edwards and Kelcey (2005) in which information was requested pertaining to rare, threatened, or endangered species, communities, and habitats, from the NJDEP New Jersey Natural Heritage Program (NJNHP) and the National Marine Fisheries. As the PEIS includes the UOP site, the results of these inquiries are considered applicable. The response from the NJNHP dated August 30, 2004 did not indicate the presence of any rare or endangered plant communities within the immediate vicinity of the Meadowlands Project. However, yellow-crowned night heron (State status threatened) foraging habitat and northern harriers (State status endangered/uncommon) exist on or within one-quarter mile of the PEIS study area. The National Marine Fisheries Service (NMFS) was contacted regarding the Endangered Species Act, the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act. In a response dated January 25, 2005, the NMFS stated that with the exception of occasional transients there are no endangered or threatened species in the Meadowlands Railroad and Roadway Improvement area. In regard to the Fish and Wildlife Coordination Act, the letter states that the anadromous and resident fish, forage and benthic species including American shad, alewife and blueback herring, striped bass, winter flounder and windowpane may be present in the project area. The NMFS also reports that Hackensack River and its tributaries have been designated as Essential Fish Habitat (EFH) for one or more species. Conservation recommendations may be made by the NMFS during the permit application process.

3.1.4 Ecotoxicity of Detected Compounds

As discussed in Section 2, chromium, mercury, PCBs, PAHs, and chlorobenzene have been detected in the streamlands and are considered pervasive at the site.

Chromium

Chromium occurs in the environment in two major valence states, trivalent chromium (III) and hexavalent chromium (VI). Chromium (III) is essential to normal glucose, protein, and fat metabolism and is thus an essential dietary element. The body has several systems for reducing chromium (VI) to chromium (III). This chromium (VI) detoxification leads to increased levels of chromium (III) (ATSDR, 1993a). Chromium (VI) is far more toxic than chromium (III), for both acute (short-term) and chronic (long-term) exposures. Chronic exposure to high levels of chromium (VI) by inhalation or oral exposure may produce effects on the liver, kidney, gastrointestinal and immune systems, and possibly the blood. Animal studies have not reported reproductive effects from inhalation exposure to chromium (VI). Oral studies have reported severe developmental effects in mice such as gross abnormalities and reproductive effects including decreased litter size, reduced sperm count, and degeneration of the outer cellular layer of the seminiferous tubules (ATSDR, 1993a). Sodium dichromate (VI) was administered by gastric intubation to groups of 10 mature male Charles Foster strain rats at levels of 20, 40, and 60 mg chromium (VI)/kg/day for 90 days. Testis weight, population of Leydig cells, seminiferous tubular diameter, testicular protein, DNA, and RNA were all significantly reduced at 40 and 60 mg chromium (VI)/kg/day (ASTDR, 1993a). Chromium (III) as chromium oxide did not cause reproductive effects in rats. Male and female rats fed 1,806 mg chromium (III)/kg/day as chromium oxide 5 days/week for 60 days before gestation and throughout the gestational period were observed to have normal fertility, gestational length, and litter size (ASTDR, 1993a).

Mercury

Mercury is persistent in the environment and may cause significant effects on ecological receptors. A variety of adverse biological effects have been attributed to mercury. Mercury is a known teratogen, mutagen, and carcinogen. It has been documented to adversely effect reproduction, growth and development, behavior, blood and serum chemistry, motor coordination, vision, hearing, histology, and metabolism at relatively low concentrations in birds and mammals. The reproduction, growth, metabolism, blood chemistry, and oxygen exchange of marine and freshwater organisms also is adversely affected by relatively low concentrations of mercury. The form of mercury most readily assimilated by biota is methylmercury. Once incorporated in tissues, methylmercury is very slow to depurate. The rate of bioaccumulation of methylmercury is species- and site-specific.

A 93-day study conducted on mink indicated that a dose of 1.8 ppm (administered orally as methyl mercury chloride) caused mortality, weight loss, and behavioral abnormalities (Wobeser et al. 1976). No adverse effects were observed at 1.1 ppm.

A one-year study conducted on Japanese quail indicated that an oral dose of 0.9 mg/kg/day (as mercuric chloride) caused reduced fertility and egg hatchability (Sample et al., 1996). No adverse reproductive effects were observed at a dose of 0.45 mg/kg/day.

Mallards fed methyl mercury during a 3-generation study showed significant reproductive effects (reduced egg and duckling production) at a daily dose 0.064 mg/kg/day (Sample et al., 1996).

PCBs

PCBs are a group of manufactured organic chemicals banned in the United States in 1977 due to proven adverse environmental effects. PCBs occur in a variety of different formulations, consisting of mixtures of individual compounds such as Aroclor 1016, 1248, 1254, and 1260. The Aroclor formulations vary in the percentage of chlorine and generally, the higher the chlorine content, the greater the toxicity. PCBs elicit a variety of biologic and toxic effects including death, birth defects, reproductive failure, liver damage, tumors, and a wasting syndrome (Eisler, 1986). These are known to bioaccumulate and to biomagnify within the food chain. Toxicity data for white-footed mice, oldfield mice, and mink show that reproductive systems and developing embryos for these organisms were adversely affected by both acute and chronic exposures (McCoy et al., 1995).

A yearlong study conducted on oldfield mice indicated that 5 mg/kg of Aroclor 1254 in the diet reduced the number of litters, offspring weights, and offspring survival (McCoy et al., 1995). A study conducted by Aulerich and Ringer (1977) exposed mink to three dose levels of Aroclor 1254 for a 4.5-month period. Exposure to 5 and 15 mg/kg in the diet reduced the number of offspring born alive, while a dose of 1 mg/kg caused no adverse effects.

PAHs

PAHs are virtually ubiquitous in nature, primarily as a result of natural processes such as forest fires, microbial synthesis, and volcanic activity. They have been detected in animal and plant tissues, sediments, soils, air, surface water, drinking water, and groundwater. Anthropogenic sources of PAHs in the environment include high temperature combustion of organic materials typical of processes used in the steel industry, heating and power generation, and petroleum refining.

Environmental concern has focused on PAHs, which range in molecular size from two-ring structures to seven-ring structures. The number of rings on the molecule strongly affects its biochemical interactions in the environment. Consequently, the fate, transport, and toxicity of PAHs correlate strongly with the size of the specific PAH molecule.

Relatively little information is known on the fate and transport of specific PAH compounds. Information on PAHs as a group is largely inferred from information on benzo(a)pyrene and mixtures of PAHs.

PAHs are moderately persistent in the environment and therefore may potentially cause significant effects to vegetation, wildlife and fish. The carcinogenicity of individual PAHs differs. Some lower weight compounds such as naphthalene, fluorene, phenanthrene, and anthracene exhibit acute toxicity and other adverse effects to some organisms, but are non-carcinogenic. In contrast, the higher molecular weight compounds are significantly less acutely toxic, but many are demonstrably carcinogenic, mutagenic, or teratogenic to a wide variety of organisms, including fish and other aquatic life, amphibians, birds, and mammals.

PAHs can be taken into the mammalian body by inhalation, ingestion or dermal contact. Acute and chronic exposure to carcinogenic PAHs have been shown to cause tumors in the stomach, lung, and skin. PAHs also have been associated with the destruction of hematopoietci and lymphoid tissues, ovatoxicity, adrenal necrosis, changes in intestinal and respiratory epithelia and immunosuppression.

The environmental effects of most non-carcinogenic PAHs are poorly understood. Available information suggests that these PAHs are not very potent teratogens or reproductive toxins. Effects include damage to the liver and kidney, and external effects of sebaceous gland ulceration.

Studies on PAH toxicity in birds indicated no mortality or visible signs of toxicity when fed 4,000 mg total PAH per kilogram of body weight for seven months. In another study, toxic and sub-lethal effects were noted at concentrations of between 0.036 and 0.18 μg PAH per egg following application of various PAHs (e.g., chrysene and benzo(a)pyrene) to the surface of mallard eggs. Another study reported acute oral effect levels for the red-winged blackbird and house sparrow and acenaphthene, phenanthrene and anthracene LD_{50}values exceeded 100 mg/kg of body weight for these species.

Few ingestion-based studies have been conducted on mammals using PAHs. Neal and Rigdon (1967) conducted a study on mice for the development of forestomach tumors. Mice were fed between 0.13 mg/kg/day and 32.5 mg/kg/day of PAH for 110 days. The highest dose produced tumors in 90 percent of the mice (Charters et al. 1996).

A study conducted on nestling European starlings indicated that a dose of 100 mg/kg/day of 7,12-dimethylbenz(a)anthracene caused an 11 percent reduction in mean body weight, a 16 percent reduction in mean hemoglobin concentrations, and a 90 percent reduction in lymphocyte proliferation (Trust et al. 1993). A dose of 10 mg/kg/day caused no adverse effects to nestling birds. Adult starlings dosed as high as 300 mg/kg/day showed no adverse effects.

Chlorobenzene

Chlorobenzene is a colorless liquid with an almond-like odor. The compound does not occur widely in nature, but is manufactured for use as a solvent (a substance used to dissolve other substances) and is used in the production of other chemicals. 1,4-dichlorobenzene is used mainly as a fumigant for the control of moths, molds, and mildews and as a space deodorant for toilets and refuse containers (ATSDR, 1993b). Tests involving acute exposure of animals, such as the LD_{50} test in rats and mice, have shown that 1,4-dichlorobenzene has moderate toxicity from oral exposure (RTECS, 1993). Studies have reported effects on the blood, liver, and kidneys from acute, oral exposure. Chronic inhalation exposures can cause adverse effects on the respiratory system, liver, and kidneys. A study on pregnant rats reported adverse developmental effects in fetuses when administering the chemical by gavage (HSDB, 1993). Chlorobenzene is persistent in soil and is known to bioaccumulate. It has low water solubility and may be absorbed by sediment organic matter.

Chronic rat studies with 1,2-dichlorobenzene indicate adverse effects on the liver and kidney at oral doses of 857 mg/kg/day (Coulston and Kolbye, 1994). Three-generation rat studies with 1,2,4-trichlorobenzene indicate adverse effects on reproduction at oral doses of 106 mg/kg/day (Coulston and Kolbye, 1994). No adverse reproductive effects were found at a dose of 53 mg/kg/day.

An oral study on the effects of 1,4-dichlorobenzene on pregnant rats, no adverse effects on maternal and developmental toxicity were observed at a dose of 250 mg/kg/day (Coulston and Kolbye, 1994). However, effects were observed at 500 mg/kg/day.

Fourteen-day studies with northern bobwhites showed adverse effect on growth and survival from oral exposures of 2500 mg/kg/day (Grimes and Jaber, 1989).

3.2 Preliminary Conceptual Model

Figure 3-2 illustrates the preliminary ecological conceptual model for the Site. Important components of the conceptual model are the identification of potential source areas, transport pathways, exposure media, potential exposure routes, and potential receptor groups. Each of these components are discussed in the following subsections.

3.2.1 Sources

As noted that the SLERA will address potential risk from contaminants in surface water and sediment in the streamlands (or OU3, or Area 4). The principal sources of contamination to the wetlands are surface and subsurface soil impacted by historical operations, sediment and waste water in the lagoons, and tidal flow and deposition of surface water and sediment via Berry's Creek.

It is suspected that surface water and sediment, impacted by offsite contaminants, have been and are being transported to OU3 via the storm sewer system that runs both underneath the Uplands property to the west and underneath the Uplands property to the north. The storm sewer system drains both the UOP Uplands area, and also a large area located to the west of Route 17.

3.2.2 Transport Pathways and Exposure Media

A transport pathway describes the mechanisms whereby site-related chemicals, once released, might be transported from a source to ecologically relevant media (sediment and surface water) where exposures might occur. These transport pathways are shown on Figure 3-2. Chemicals can be released from soil through infiltration and discharged from groundwater into sediment and surface water. Chemicals bound to soil particles can be transported by surface runoff during storm events to downgradient waterbodies or deposited directly on the surface water body itself by wind during dry conditions. Chemicals may have also been released to sediment and surface water by direct discharge from the lagoon during overflow conditions. Contaminants sorbed to sediment may be transported by surface water in areas of high flow and later deposited in areas of low energy. Tidal fluctuations at the site generate conditions of high and low flow. Chemicals which enter surface water bodies either directly (through deposition from air) or indirectly (via surface runoff or groundwater discharge) might remain suspended in the water column and/or might be transported to sediments.

3.2.3 Exposure Pathways and Routes

An exposure pathway links a source with one or more receptors through exposure via one or more media and exposure routes. Exposure, and thus potential risk, can only occur if complete exposure pathways exist. Figure 3-2 shows the potentially complete and significant exposure pathways to aquatic ecological receptors.

An exposure route describes the specific mechanism(s) by which a receptor is exposed to a chemical present in an environmental medium. Unrooted, floating aquatic plants, and rooted submerged vascular aquatic plants and algae, might be exposed to chemicals directly from the water column or (for rooted plants) from sediments. Animals might be exposed to chemicals through: (1) the incidental ingestion of contaminated abiotic media (e.g., sediment) during feeding activities; (2) the ingestion of contaminated water; (3) the ingestion of contaminated plant and/or animal tissues for chemicals which have entered food webs; and/or (3) dermal contact with contaminated abiotic media. These exposure routes, where applicable, are depicted on Figure 3-2.

The relative importance of these exposure routes depends in part on the chemical being evaluated. For chemicals having the potential to bioaccumulate, such as PCBs, the greatest exposure to wildlife is likely to be from the ingestion of prey. For chemicals having a limited potential to bioaccumulate, the exposure of wildlife to chemicals is likely to be greatest through the direct ingestion of the contaminated sediment.

Dermal and inhalation exposures will not be evaluated in the ERA for upper trophic level receptors due to the limitation of available data. Based upon the general fate properties (e.g., relatively high adsorption to solids) of the chemicals (e.g., PAHs) and the protection offered by hair or feathers, dermal exposures following deposition to sediment for upper trophic level receptor species are not likely to be significant relative to ingestion exposures. Incidental ingestion of sediment during feeding activities will, however, be considered in the risk estimates. Direct contact, however, will be considered for lower trophic level receptors (e.g., invertebrates).

3.2.4 Receptors

Due to the complexity of natural systems, it is generally not possible to directly assess potential impacts to all ecological receptors present within an area. Therefore, a limited number of receptor species or species groups will be selected as surrogates to represent the larger components of the ecological community. Receptor selection is guided by the results of the site habitat characterization, resident species information and consideration of the following:

- Are known to occur or are likely to occur at the Site
- Have a particular ecological, economic or aesthetic value
- Are representative of taxonomic groups, life history traits and/or trophic levels in the habitats present at the Site for which complete exposure pathways are likely to exist

- Are rare, threatened, or endangered
- Can be expected to represent potentially sensitive populations at the Site due to toxicological sensitivity or potential exposure magnitude
- Have sufficient ecotoxicological information available on which to base an evaluation

A preliminary list of specific receptor species and species groups proposed for evaluation in the SLERA is presented in this technical memorandum. The final selection of receptor species and groups will be made at the time the SLERA is conducted and may be revised based on chemicals detected in sample media and refinements to the conceptual site model.

Lower trophic level receptor species will be evaluated based upon those taxonomic groupings for which medium-specific screening values have been developed; these groupings and screening values are used in most ecological risk assessments. As such, specific species of aquatic biota (e.g., mummichog) were not chosen as receptor species; aquatic biota will be addressed on a community level via a comparison to surface water and sediment screening values.

In addition to evaluating risk to aquatic biota on a community level, exposure of fish to site contaminants will be evaluated quantitatively by calculating tissue concentrations in fish using biosediment accumulation factors (BSAFs). The estimated tissue concentrations in fish will be compared to tissue concentrations noted in the literature that are associated with adverse effects. It should be noted that fish tissue toxicity information is limited and not available for all species of fish or all contaminants.

Upper trophic-level receptor species will be selected for evaluation based on the general guidelines presented in USEPA guidance (USEPA, 1991). Receptor species identified for evaluation and their trophic levels are as follows:

- Raccoon (*Procyon lotor*) - semi-aquatic mammalian omnivore
- Muskrat (*Ondatra zibethica*) – semi-aquatic herbivore
- Spotted sandpiper (*Actitis macularius*) – aquatic avian invertivore
- Black duck (*Anas rubripes*) – aquatic avian omnivore
- Yellow-crowned night heron (*Nyctanassa violacea*) - wetland/aquatic avian piscivore

Upper trophic level receptor species quantitatively evaluated in the ERA will be limited to birds and mammals (as shown in the preceding list), the taxonomic groups with the most available information regarding exposure and toxicological effects. Individual species of amphibians and reptiles were not selected for evaluation due to the general lack of available toxicological information for these taxonomic groups. Potential risks to amphibians and reptiles from exposure via the food web will be evaluated using other fauna (birds and mammals) as surrogates. Potential risks to these groups from direct exposures to sediment and surface water will be evaluated using screening values developed for other taxonomic groups (described above).

3.2.5 Assessment and Measurement Endpoints

The conclusion of the problem formulation includes the selection of ecological endpoints, which are based upon the conceptual model. Two types of endpoints, assessment endpoints and measurement endpoints, are defined as part of the ERA process (USEPA, 1992 1997, 1998). An assessment endpoint is an explicit expression of the environmental component or value that is to be protected. A measurement endpoint is a measurable ecological characteristic that is related to the component or value chosen as the assessment endpoint. The considerations for selecting assessment and measurement endpoints are summarized in USEPA (1992, 1997) and discussed in detail in Suter (1989, 1990, 1993).

Endpoints in the ERA define ecological attributes that are to be protected (assessment endpoints) and a measurable characteristic of those attributes (measurement endpoints) that can be used to gauge the degree of impact that has or might occur. Assessment endpoints most often relate to attributes of biological populations or communities, and are intended to focus the risk assessment on particular components of the ecosystem that could be adversely affected by chemicals attributable to the site (USEPA, 1997). Assessment endpoints contain an entity (e.g., muskrat population) and an attribute of that entity (e.g., survival rate). Individual assessment endpoints usually encompass a group of species or populations (the receptor) with some common characteristic, such as specific exposure route or contaminant sensitivity, with the receptor then used to represent the assessment endpoint in the risk evaluation.

Assessment and measurement endpoints might involve ecological components from any level of biological organization, from individual organisms to the ecosystem itself (USEPA, 1992). Effects on individuals are important for some receptors, such as threatened and/or endangered species (none are likely to regularly occur within the assessment area); population- and community-level effects are typically more relevant to ecosystems. Population- and community-level effects are usually difficult to evaluate directly without long-term and extensive study. However, measurement endpoint evaluations at the individual level, such as an evaluation of the effects of chemical exposure on reproduction, can be used to predict effects on an assessment endpoint at the population or community level. In addition, use of criteria values designed to protect the vast majority (e.g., 95 percent) of the components of a community (e.g., Ambient Water Quality Criteria for the Protection of Aquatic Life) can be useful in evaluating potential community- and/or population-level effects.

Table 3-2 summarizes the preliminary assessment and measurement endpoints selected for the ERA. These will be modified, as necessary, once the environmental setting evaluation is completed and a final list of receptors is selected.

3.3 Screening-Level Effects Assessment (Step 1)

The screening-level effects assessment establishes chemical exposure levels (screening concentrations and doses) that represent conservative thresholds for adverse ecological effects. Both media-specific and ingestion screening values are developed in this evaluation.

3.3.1 Media-Specific Screening Values

Surface water

Principal sources of surface water screening values for include:

- National Ambient Water Quality Criteria (USEPA, 2002)
- New Jersey Water Quality Standards (NJDEP, 2003)
- USEPA Ecotox Thresholds (USEPA, 1996)
- Scientific literature, such as the AQUIRE database (USEPA, 2003; Buchman (1999), and Suter and Tsao (1996)

Alternate sources may also be suggested for compounds without screening values. As the salinity on the site is roughly one-eighth that of seawater (ENSR, 199) and both freshwater and marine aquatic species may be found on-site, where both marine/saltwater and freshwater screening values are available, the lowest value will be used to be protective of all species on-site (USEPA, 2002). Surface water screening values for several divalent metals require site-specific adjustment based on water hardness. Adjustments to these screening values will be made with the average hardness. If no site-specific hardness is available a default, conservative hardness of 100 mg $CaCO_3$/L will be used for such adjustments.

For chemicals known to bioaccumulate in aquatic food webs, screening values will be based upon the final chronic value (rather than the final residue value) as per USEPA (1996) and Suter and Tsao (1996). The use of final chronic values is intended to protect ecological receptors from direct exposures to chemicals in surface water, rather than from exposure via the food chain. Potential risks to upper trophic level receptors from food chain exposures (tissue residues) will be evaluated separately.

Sediment

Sediment screening values for inorganics and organics will be obtained primarily from *NJDEP's Guidance for Sediment Quality Evaluations, November 1998.* As these screening values are from OME (1993) and Long et al. (1995), screening values will also be obtained from these original sources for chemicals not listed in NJDEP (1998), if any. Alternate sources including Long and Morgan, (1990), Buchman (1999), and USEPA (1996), may also be suggested for compounds without screening values. Where both marine/saltwater and freshwater screening values are available, the lowest value will be used. The rationale for selecting each sediment screening value will be provided.

Because these sediment screening values are typically based on studies that correlate chemical concentrations in sediments with some measure of benthic community impairment, sediment screening values associated with adverse effects in fish will also be obtained if available.

3.3.2 Ingestion Screening Values

Ingestion screening values for dietary exposures will be derived for each avian and mammalian receptor species, and each detected chemical. Toxicological information from the literature for wildlife species most closely related to the receptor species will be used but will be supplemented by laboratory studies of non-wildlife species (e.g., laboratory mice) where necessary. The ingestion screening values are expressed as milligrams of the chemical per kilogram body weight of the receptor per day (mg/kg-BW/day) for birds and mammals. Fish exposure will be evaluated using fish tissue concentrations estimated from sediment concentrations using BSAFs as described in Section 3.4.2 and fish tissue concentrations associated with adverse effects (expressed as mg/kg wet weight or dry weight)

The following guidelines will be used when selecting and developing ingestion-based screening values for wildlife:

- Toxicological information for test species most closely related to the surrogate species will be used preferentially. Data will be supplemented by laboratory studies of non-wildlife species (e.g., laboratory mice) where necessary to derive the screening toxicity values.

- Growth and reproduction will be emphasized in the assessment endpoints since they are the most relevant, ecologically, to maintaining viable populations and as they are generally the most studied chronic toxicological endpoints for ecological receptors.

- No Observed Adverse Effect Levels (NOAELs) will be used preferentially as screening values. A NOAEL represents the highest level (or dose) of a stressor evaluated in a toxicity test or biological field survey that causes no statistically significant difference in effect compared with the controls or a reference (USEPA, 1997). NOAELs based on chronic effects will be used preferentially as they typically account for more subtle adverse effects that would occur at lower doses than acute effects. If several chronic toxicity studies are available from the literature, the appropriate study or studies will be identified for each receptor species based on study design, study methodology, study duration, study endpoint and test species. If more than one toxicity study is determined to be relevant, the lowest values will be conservatively selected for use as the screening value. Chronic Lowest Observed Adverse Effect Levels (LOAELs) or acute values of the Lethal Dose to 50 percent of a population (LD_{50}) will be used to derive or extrapolate a substitute value to use in place of the chronic NOAELs if chronic NOAEL values are unavailable for a chemical. LOAELs represent the lowest dose of a chemical at which an effect being measured in a toxicity test occurs, while an LD_{50} represents the dose of a chemical at which half of the organisms being tested perish. An uncertainty factor of 10 will be used to convert a reported LOAEL to a NOAEL (i.e., the LOAEL will be multiplied by 0.1 to obtain the chronic NOAEL), while an uncertainty factor of 100 will be used to convert the acute LD_{50} to a chronic NOAEL (i.e., the LD_{50} will be multiplied by 0.01 to obtain the chronic NOAEL).

Fish exposure will be evaluated using fish tissue concentrations estimated from sediment concentrations using BSAFs as described in Section 3.2.4 and fish tissue concentrations identified in the literature associated with adverse effects.

3.4 Screening-Level Exposure Assessment (Step 2)

The screening-level exposure assessment summarizes the analytical data to be considered for use in the SLERA, the data groupings, and the exposure models and input parameters that will be used to estimate the potential exposure of ecological receptors to chemicals.

Consistent with the objectives of the SLERA, conservative assumptions will be used in models estimating the potential exposure of ecological receptors to chemicals in the environment. Direct exposure and food-web exposure are evaluated in this step.

3.4.1 Direct Exposure

Maximum concentrations in surface water and sediment will be used to conservatively estimate potential chemical exposures for the ecological receptors selected to represent the assessment endpoints at each site. For conservatism, the maximum reporting limit for chemicals that were analyzed for but not detected will also be compared to medium-specific screening values and (where applicable) used for food web exposure modeling. This is done to ensure that reporting limits are similar to, or less than, chemical concentrations at which potential adverse effects to ecological receptors may occur. For samples with duplicate analyses, the higher of the two concentrations will be used in the screening (i.e., when both values are detects or both values are non-detects). In cases where one result was a detection and the other a non-detect, the detected value will be used in the assessment.

Available analytical data will be selected for use in the screening ERA based on a set of selection criteria that include:

- Data must be validated by a qualified data validator using acceptable data validation methods. Rejected (R) values will not be used in the ERA. Unqualified data and data qualified as J, L, or K will be treated as detected. Data qualified as U or B will be treated as non-detected.
- For sediment, samples from depths of 0 to 6 inches will be used preferentially since this depth range represents the most realistic exposures for sediment-dwelling species.
- For surface water, total (unfiltered) chemical concentrations will be used in the screening ERA for conservatism. Dissolved metals data will be reported, if collected, but will not be used in exposure estimation until Step 3a (if the ERA progresses to this step).

3.4.2 Prey Items

Exposures for upper trophic level receptor species via the food web will be determined by estimating the chemical-specific concentrations in each dietary component using uptake and food web models. Incidental ingestion of sediment and ingestion of water will also be included when calculating the total level of exposure. Maximum sediment and/or surface water concentrations will be used in all calculations to provide a conservative assessment.

Estimates for food web exposures will be based on bioaccumulation factors developed from the literature. The uptake of chemicals from the abiotic media into these food items will be based on conservative (e.g., maximum or 90th percentile) bioconcentration factors (BCFs) or bioaccumulation factors (BAFs). Default factors of 1.0 (dry weight to dry weight) will be used only where data are unavailable for a chemical in the literature. The receptor species used in the ERA will be selected to represent only complete exposure pathways identified in the conceptual model.

Dietary items for which tissue concentrations may be modeled include aquatic plants, aquatic invertebrates, and fish. The methodology and models used to derive these estimates are described below.

Aquatic Plants. Tissue concentrations in the above-ground vegetative portion of rooted aquatic plants will be estimated by multiplying the maximum measured sediment concentration for each chemical by chemical-specific sediment-to-plant BCFs obtained from the literature. The BCF values used will be based on root uptake from sediment and on the ratio between dry-weight sediment and dry-weight plant tissue. Literature values based on the ratio between dry-weight sediment and wet-weight plant tissue will be converted to a dry-weight basis by dividing the wet-weight BCF by an estimated solids content for aquatic plants (15 percent [0.15]; Sample et al., 1997).

For inorganic chemicals without literature based BCFs, a sediment-to-plant BCF of 1.0 will be assumed. For organic chemicals without literature based BCFs, sediment-to-plant BCFs will be estimated using the algorithm provided in Travis and Arms (1988):

$$\log B_v = 1.588 - (0.578)(\log K_{ow})$$

where: B_v = Sediment-to-plant BCF (unitless; dry weight basis)

K_{ow} = Octanol-water partitioning coefficient (unitless)

Tissue concentrations for unrooted aquatic plants will be estimated by multiplying the maximum measured surface water concentration by a water-to-plant BCF obtained from the literature.

Aquatic Invertebrates. Tissue concentrations in aquatic invertebrates will be estimated by multiplying the maximum measured sediment concentration for each chemical by chemical-specific sediment-to-invertebrate BCFs obtained from the literature. The BCF values will be based on the ratio between dry-weight sediment and dry-weight invertebrate tissue. BCFs based on depurated analyses (sediment was purged from the gut of the organism prior to analysis) will be given preference over undepurated analyses when selecting BCF values since direct ingestion of sediment is accounted for separately in the food web model.

Literature values based on the ratio between dry-weight sediment and wet-weight invertebrate tissue will be converted to a dry-weight basis by dividing the wet-weight BCF by an estimated solids content for aquatic invertebrates (21 percent [0.21]; USEPA, 1993). For chemicals without literature based sediment-to-invertebrate BCFs, a BCF of 1.0 will be assumed.

Fish. Tissue concentrations in whole-body fish will be estimated by multiplying the maximum measured sediment concentration for each chemical by chemical-specific sediment-to-fish BCFs obtained from the literature. The BCF values will be based on the ratio between dry-weight sediment and dry-weight fish tissue. Literature values based on the ratio between dry-weight sediment and wet-weight fish tissue will be converted to a dry-weight basis by dividing the wet-weight BCF by the estimated solids content for fish (25 percent [0.25]; USEPA, 1993). For chemicals without literature based sediment-to-fish BCFs, a BCF of 1.0 will be assumed.

Dietary intakes for each receptor species will be calculated using the following formula (modified from USEPA [1993]):

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

where:

where:	DI_x	=	Dietary intake for chemical x (mg chemical/kg body weight/day)
	FIR	=	Food ingestion rate (kg/day, dry weight)
	FC_{xi}	=	Concentration of chemical x in food item i (mg/kg, dry weight)
	PDF_i	=	Proportion of diet composed of food item i (dry weight basis)
	SC_x	=	Concentration of chemical x in sediment (mg/kg, dry weight)
	PDS	=	Proportion of diet composed of sediment (dry weight basis)
	WIR	=	Water ingestion rate (L/day)
	WC_x	=	Concentration of chemical x in water (mg/L)
	BW	=	Body weight (kg, wet weight)

As discussed in USEPA (1997), exposure parameter values used in this food web model are selected to provide for a conservative evaluation in Step 2. Examples of these conservative assumptions include:

- All of the dietary items consumed by the receptor are obtained from the site (i.e., an Area Use Factor of 1 is assumed) at the point of maximum concentrations.
- Chemicals are 100 percent bioavailable.
- Maximum ingestion rates are used (calculated maximum ingestion rates are based on the maximum body weight).
- Minimum body weights are used.

3.5 Screening-Level Risk Calculation and Uncertainties (Step 2)

The screening-level risk calculation is the final step in a SLERA. In this step, the maximum exposure concentrations (i.e., direct exposure to environmental media) or the exposure doses (i.e., ingestion/dietary dosage for upper trophic-level receptor species) are compared to the corresponding screening values to derive screening risk estimates. The outcome of this step is a list of COPCs for each media-pathway-receptor combination evaluated.

COPCs will be determined using the hazard quotient (HQ) method. HQs for direct exposure will be calculated by dividing the maximum detected chemical concentration in the media being evaluated by the corresponding media-specific screening value. HQs for exposure of higher trophic-level species to chemicals via ingestion will be calculated by dividing the maximum estimated exposure dose by the corresponding ingestion screening value. Chemicals with HQs greater than or equal to 1.0 (i.e., the chemical concentration is equal to or greater than the screening value) will be considered COPCs. In the SLERA, chemicals without screening values will also be retained as COPCs. However, chemicals that are not detected and do not have screening values will be eliminated as COPCs later in the assessment.

HQs greater than or equal to one will be interpreted as indicating the potential for unacceptable risk to ecological receptors since the chemical exposure concentration or dose exceeds a toxicity threshold represented by the screening value. It should be noted, however, that screening values and exposure estimates in the SLERA will be derived using several conservative assumptions such that HQs greater than one will not conclusively indicate that unacceptable risks are present or that impacts on ecological receptors are occurring. HQs that are less than one will indicate that the potential for unacceptable risk is very unlikely. In these cases, the SLERA will conclude with a high degree of confidence that no unacceptable risk exists. An HQ equal to or less than one eliminates the need for further evaluation of the chemical-pathway-receptor combination in the ERA.

Once the screening ERA is complete, the results will be evaluated to identify the type and magnitude of uncertainty associated with the risk conclusions. Reliance on results from a risk assessment can be misleading without a consideration of uncertainties, limitations, and assumptions inherent in the process. Uncertainties are present in all risk assessments due to the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. Since conservative assumptions will be used in the exposure and effects assessments, these uncertainties are more likely to result in an overestimation rather than an underestimation of the likelihood and magnitude of risks to ecological receptors at the screening level.

3.6 Screening-Level Decision Point (Step 2)

The results of the screening ERA will be used to evaluate the status of the UOP Streamlands site in terms of potential ecological risk. Following the screening ERA, possible decision points are:

- No further action is warranted. This decision is appropriate if the screening ERA indicates that sufficient data are available on which to base a conclusion of no unacceptable risk.
- Further evaluation is warranted. This decision is appropriate if the screening ERA indicates that there is the potential for unacceptable risks for some pathways, receptors, and chemicals. In this instance, the ERA would progress to Step 3a

wherein the risk estimates would be refined based on more realistic and site-specific assumptions and data.

- Further data are required. This decision is appropriate if the screening ERA indicates that there are insufficient data on which to base a risk estimate. This decision may also be appropriate if the potential for unacceptable risks is identified following the screening ERA and additional data to refine these estimates (e.g., additional analytical data, measures of bioavailability, etc.) are needed for Step 3.

3.7 Baseline ERA (Step 3)

If the results of the screening ERA suggest that further ecological risk evaluation or data collection is warranted, the ERA process would proceed to the baseline ERA which is a more detailed phase of the ERA process (Steps 3 through 7).

The first step of the baseline ERA (Step 3) is the baseline problem formulation. The baseline problem formulation refines the risk estimates from the screening ERA using more realistic exposure assumptions (Step 3a), and if unacceptable risks are still possible, refines the conceptual model and endpoints (Step 3b) in order to determine the direction of subsequent steps of the ERA process.

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Table 3-1

Plant Species Reported in the Project Area for the Meadowlands Railroad and Roadway Improvement Project (Edwards and Kelcey, 2005)

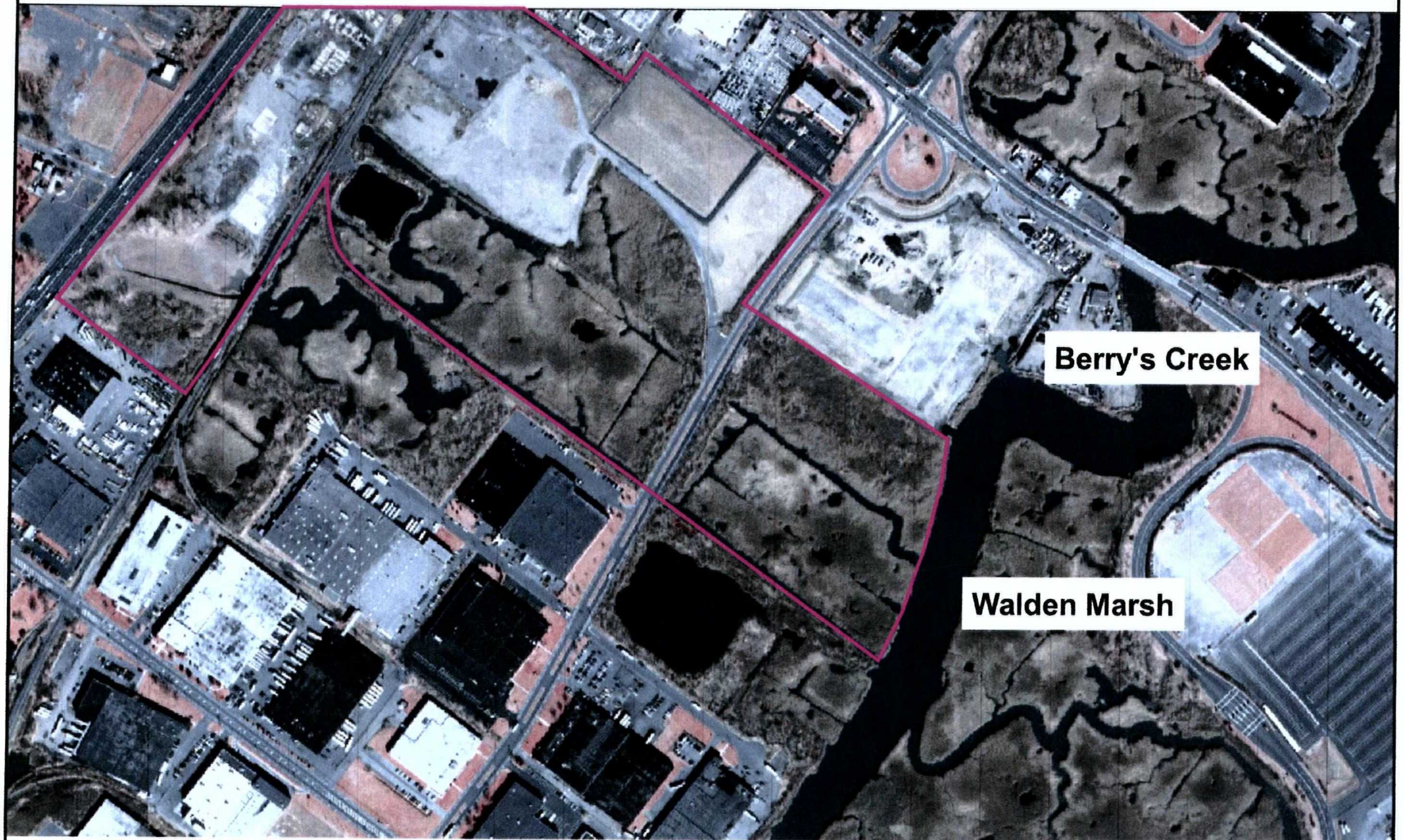
Honeywell UOP Streamlands, East Rutherford, Bergen County, NJ

Common Name	Scientific Name
Silver maple	*Acer saccharinum*
Tree-of-Heaven	*Ailanthus altissima*
Garlic mustard	*Alliaria petiolata*
Field garlic	*Allium vineale*
Marsh waterhemp	*Amaranthus cannibinus*
Common ragweed	*Ambrosia artemisifolia*
Spreading dogbane	*Apocynum androsaemifolium*
Burdock	*Arctium minus*
mugwort	*Artemesia vulgaris*
Common milkweed	*Aslepias syrias*
Groundsel tree	*Baccharis halimifolia*
Tussock sedge	*Carex stricta*
Pignut hickory	*Carya glabra*
Northern catalpa	*Catalpa speciosa*
Asiatic/Oriental bittersweet	*Celastrus orbiculatus*
Chicory	*Cicharium intybus*
Bull thistle	*Cirsium vulgare*
Lambs quarter	*Chenopodium album*
Crown vetch	*Coronilla varia*
Nut Sedge	*Cyperus strigosis*
Queen Anne's lace	*Daucus carota*
Russian olive	*Elaeagnus augustifolia*
Spike rush	*Eleocharis sp*
Daisy fleabane	*Erigeron annuus*
Wild strawberry	*Fragaria virginiana*
Jewelweed	*Impatiens capensis*
Marsh elder	*Iva frutescens*
Soft rush	*Juncos effuseu*
Black grass	*Juncos gerardii*
Tartarian honeysuckle	*Lonicera tatarica*
Purple loosestrife	*Lythrum salicaria*
Red mulberry	*Morus rubra*
Common evening primrose	*Oenothera biennis*
Sensitive fern	*Onoclea sensibilis*
Princess tree	*Paulownia tomentosa*
Common reed	*Phragmites australis*
Common pokeweed	*Phytolacca Americana*
Pitch pine	*Pinus rigida*
Northern white pine	*Pinus strobes*
Common plaintain	*Plantago major*
Salt marsh fleabane	*Plunchea purpurascens*
smartweed	*Polygonum sp*
Japanese knot weed	*Polygonum cuspidatum*
Eastern cottonwood	*Populus deltoids*
Black cherry	*Prunus serotina*
White oak	*Quercus alba*
Black locust	*Robinia pseudoacacia*
Multiflora rose	*Rosa multiflora*
Dock sp.	*Rumex sp.*
Weeping willow	*Salix babylonica*
Common three-square	*Scirpus americanus*
Horse nettle	*Solanum caolinense*
Rough-stemmed goldenrod	*Solidago rugosa*
Saltmeadow cordgrass	*Spartina patens*
Poison ivy	*Toxicodendron radicans*
Eastern hemlock	*Tsuga Canadensis*
American elm	*Ulmus Americana*
Common mullien	*Verbascum thapsus*
Fox grape	*Vitis labrusca*

Table 3-2
Assessment and Measurement Endpoints
Honeywell UOP Streamlands, East Rutherford, Bergen County, NJ

Assessment Endpoint	Measurement Endpoint	Receptor
Wetland and Aquatic Habitats		
Survival, growth, and reproduction of benthic and aquatic invertebrate communities	Comparison of chemical concentrations in surface water and sediment with medium-specific screening values	Benthic/aquatic invertebrates
Survival, growth, and reproduction of aquatic and wetland plant communities	Comparison of chemical concentrations in surface water with surface water screening values	Aquatic/wetland plants
Survival, growth, and reproduction of fish communities	Comparison of chemical concentrations in surface water and sediment with screening values; Comparison of literature-derived chronic No Observed Effect Concentration (NOEC) fish tissue values for survival, growth, and reproduction based on sediment concentrations and accumulation factors	Fish
Survival, growth, and reproduction of mammalian aquatic/wetland omnivores	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on surface water and sediment concentrations	Raccoon
Survival, growth, and reproduction of mammalian aquatic/wetland herbivore	Comparison of literature-derived chronic NOAEL values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on surface water and sediment concentrations	Muskrat
Survival, growth, and reproduction of avian aquatic/wetland piscivores	Comparison of literature-derived chronic NOAEL values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on surface water and sediment concentrations	Yellow-crowned night heron
Survival, growth, and reproduction of avian aquatic omnivores	Comparison of literature-derived chronic NOAEL values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on surface water and sediment concentrations	Black duck
Survival, growth, and reproduction of aquatic and wetland reptiles	Evidence of potential risk to other upper trophic level aquatic and wetland receptors evaluated in the ERA	--
Survival, growth, and reproduction of amphibians	Evidence of potential risk to other upper trophic level aquatic and wetland receptors evaluated in the ERA	--

\\Aphrodite\projects\18gis\other\UOP\Figures\Figure 2-1 - Site Location Map.mxd



Legend

Boundary of UOP Site

N
W E
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Figure 2-1
Site Location Map
Universal Oil Products
(UOP) East Rutherford, NJ

CH2MHILL

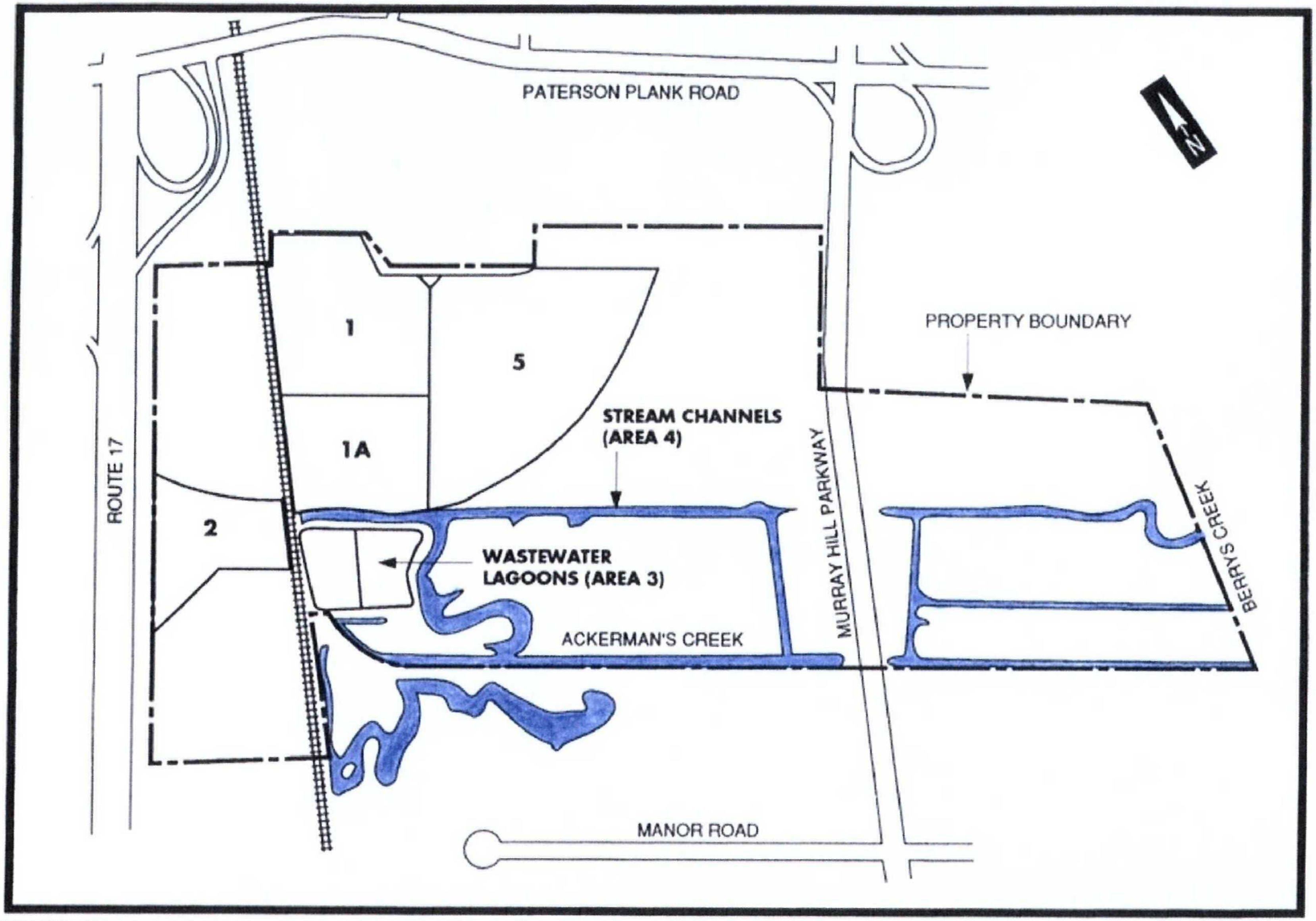

Figure 2-2
UOP Operational Areas
Universal Oil Products
(UOP), East Rutherford, NJ

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\\Aphrodite\projects\18gis\other\UOP\Figures\Figure 3-1 - UOP Site and Surrounding Water Bodies.mxd

Legend

UOP_Site_Boundary_meadowlands

N
W E
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Figure 3-1
UOP Site and Surrounding Water Bodies
Universal Oil Products
(UOP) East Rutherford, NJ

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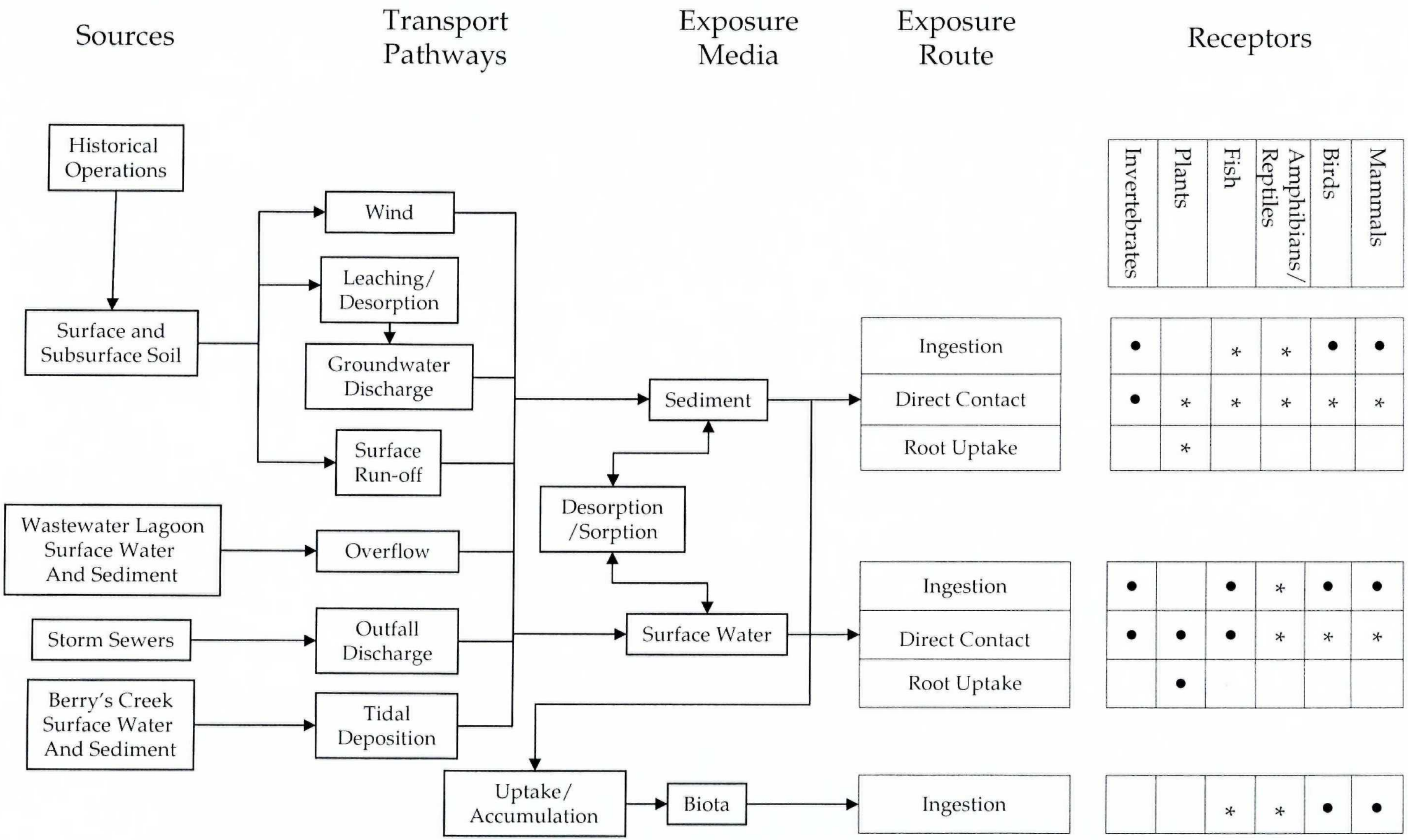

Exposure Media	Exposure Route	Invertebrates	Plants	Fish	Amphibians/ Reptiles	Birds	Mammals
Sediment	Ingestion	•		*	*	•	•
Sediment	Direct Contact	•	*	*	*	*	*
Sediment	Root Uptake		*				
Surface Water	Ingestion	•		•	*	•	•
Surface Water	Direct Contact	•	•	•	*	*	*
Surface Water	Root Uptake		•				
Biota	Ingestion			*	*	•	•

Figure 3-2. Preliminary Ecological Conceptual Site Model

• Pathway evaluated quantitatively
* Pathway not evaluated quantitatively (see text)